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ABSTRACT

One area explored in the second (in-depth) phase of the Learning in Science Project was "children's science," defined as views of the world and the meanings for words that children have and bring with them to science lessons. The investigation reported focuses on students' (N=39) ideas on the concept of "animal." Data were obtained by the "interview-about-instances" (IAI) procedure in which students were shown diagrams on cards which represented different instances (such as frog) and non-instances (such as fire) of "animal." Additional data were obtained from a 6-question, multiple-choice test, based on the IAI, administered to a larger sample (including high school and college students). Selections from interview transcripts are presented, discussed, and analyzed as they relate to: (1) classification according to biologists' criteria, focusing on the following attributes--number of legs, size, habitat, presence of fur, and noise production; (2) confusion between scientific attributes of living things and those of animals; and (3) use of scientifically acceptable criterial attributes. Selected findings reported indicate that 35 students could not classify all animal instances correctly and (from multiple-choice test results) that 14 percent of Form 1 students, 59 percent of Teachers College students, and 97 percent of university students correctly categorized all six instances. Implications for biology instruction are addressed based on these results. (JN)

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ANIMALS

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WORKING PAPER No. 22

In our view successful science teaching requires an appreciation not only of the scientists' view of the world, but also an appreciation of the language, the beliefs and the expectations which children bring with them to science classes. This working paper has developed from a study carried out in the in-depth phase of the Learning in Science Project and is one of a series of papers which explores aspects of Children's Science (see Working Paper No. 14). It is our hope that these papers portray children's views of the world and meanings for words in a way which will be useful to teachers and to curriculum developers.

In the action-research phase of the project it is our intention to attempt to build practical and useful teaching strategies based on the findings of the in-depth phase of the project. For this reason we are actively seeking comments on the findings we have detailed, and seeking information on the variety of ways teachers develop ideas associated with the topic under focus in this paper.

We would be grateful if comment and/or information could be forwarded to

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Animal[1]

A Working Paper of the Learning in Science Project

Beverley Stead

November 1980

Introduction

As part of the in-depth phase of the Learning in Science Project, it was decided to investigate children's views on several different aspects of science. One such investigation was to describe the meanings and uses of the words 'living', 'animal' and 'plant' - three commonly used biological words. This paper presents the findings related to the word 'animal'. A full account of the entire investigation may be found in Stead (1980a).

Comments obtained from teachers (and others involved in science education) in the exploratory phase of the Learning in Science Project indicated that the ecology in the Forms 1-4 science syllabus gave concern to some teachers. In particular, concepts to be dealt with were too abstract for the children, and also the children lacked the prerequisite knowledge of different kinds of animals and plants to cope with the abstract and superordinate concepts of ecology, for example, energy relationships and adaptation. These findings present a mismatch to an assumption stated in the 1967 Forms 1 and 2 science syllabus, and implied in the Draft Syllabus for Science in Forms 1 - 4 (1978), namely:

> "In Standards 1 to 4, pupils will have studied a variety of plants and animals selected from the nature study syllabus. These will have been dealt with more or less as separate species, and as a result, it will be assumed that Form 1 pupils will have a general knowledge of form, habits, methods of feeding, and life histories of a considerable range of species, both plant and animal."
>
> (1967 syllabus, p 5)

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1 This paper is a slightly modified form of the paper The description and modification of some students biological concepts. Presented to the New Zealand Association for Research in Education, Massey University, Palmerston North, 28-30 November 1980.

The results of another in-depth phase investigation into children's meanings and uses of the word 'energy' (Stead, 1980) indicated many pupils, including Form 5 pupils, have a limited concept of energy compared to that of a scientist, and that many pupils illustrated an inability to cope with the abstract nature of the concept. Even at Form 5 level, teachers cannot assume that pupils have a scientifically acceptable concept of food chains and energy flow, even though community organisation is stressed at both the Form 1 and 2 and Form 3 and 4 levels.

These two sets of results question the appropriateness of including ecological studies, in their present form, in the Forms 1-4 science syllabus. But what is appropriate? To clarify this issue educational researchers, curriculum developers and teachers need to be aware of what concepts the pupils already hold, and work from this base. As Ausubel states:

> "the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly."
>
> (Ausubel, 1968, p vi)

The word 'animal' is commonly used in biological texts and lessons and is a label for a concept basic to a study of biology. It is frequently assumed that pupils have a scientifically acceptable concept of 'animal', and the word is used without explanation.

But what concepts of 'animal' do pupils hold? This investigation describes the concepts of 'animal' held by some school pupils and tertiary students.

The Qualitative Phase

In this phase of the investigation, the method of obtaining data was an 'interview-about-instances' procedure developed by Osborne and Gilbert, (1979). This method is based on a definition of a concept which states that a person is said to have a particular concept if she can distinguish between instances and non-instances of the concept and give the reasoning (the set of criterial attributes) behind the action. This definition reflects those of Gagnè (1970), Markle and Tiemann (1970) and Frayer et al (1972).

For example, a person is said to have a scientifically acceptable concept of an animal if (s)he can distinguish between instances of the concept (for example, dog, whale, bird, snail) and non-instances (for example, grass, car, mushroom) and give the reasoning behind the action. A biologist would use the reasons (or criterial attributes) of heterotrophic feeding (feeding on other living things), muscular movement, sense organs, nervous system, and cellular structure to distinguish animals from other living things. However, no one of these criteria can be considered as adequate alone, as exceptions exist in all cases. The categorisation of an instance depends on the joint presence of several but not all of the criterial attributes.

Thirty nine average ability pupils (see Figure 1) from Standard 4, Form 1, Form 3 and Form 5 classes were shown, in an interview situation, drawings on cards which represented different exemplars and non-exemplars of the scientific concept 'animal'.

The illustrations on the cards shown, in the order of presentation, were ; seagull, cow, spider, worm, grass, cat, mushroom, rock cod, boy, frog, snail, elephant, snake, fire, lion, whale, car, tree, and butterfly. Instances of animals, plants and non-living instances were presented. A sample of the cards is given in Figure 2.

The interviews were structured in the sense that the sequence of cards was the same and the same two questions were asked with each card in the interview. The two questions asked were:

1. "Is the _____ an animal?"
2. "What tells you that?"

The first question investigated if the pupils categorised the instance as an exemplar or non-exemplar of the concept; the second investigated the reasoning (the set of criterial attributes) used to make the categorisation. However, further questions were asked when appropriate, in order to gain a clearer understanding of each pupil's concept under investigation. The beginning of each interview, after introductions, was as follows:

> "I'm interested in science lessons and, in particular the different meanings people have for different words. For example, the teacher may use a word in class, you'll mean one thing by it and the person sitting next to you may mean something else, something slightly different. I would like to learn from you what you mean by the word 'animal'."

The first question with the first card (and with later cards if need be) was

> "In your meaning of the word 'animal' is a _____ an animal?"

At the end of an interview the pupil was asked to give her/his meaning of the word 'animal' in a sentence or two.

The pupils were individually interviewed in a small room or office. The interviews were taped with the consent of the pupil, and later transcribed to obtain a written record of the interview for the later collation of results.

The perceived criterial attributes where used to provide a framework upon which the data from the interviews could be analysed. The findings discussed in this paper are illustrated or supported with quotations from the transcripts. An example of such a quotation is:

> "Yes, it eats other animals." (lion, 304, 307, 505, 508)

The interpretation of this quote is as follows:

1. The 'yes' was the answer given to the first question, "Is the lion an animal?". The lion was categorised as an animal.

2. 'it eats other animals' was the reply to the second question, "What tells you that?". That "it eats other animals" was the criterial attribute used to categorise the lion as an animal.

3. 'Lion' indicates the instance to which this quote refers.

4. The number 304, indicates the pupil whose answer is quoted.

5. Numbers 307 to 508 indicate the pupils who gave answers, similar in meaning to that of pupil 304, but not necessarily identical in wording.

6. The triple code number, eg 304, represents one pupil. The first number indicates the class level (0 for Standard 4; 1 for Form 1; 3 for Form 3; and 5 for Form 5). The next two numbers refer to a particular pupil. For example, pupil 307 was the seventh pupil interviewed from Form 3.

Only two or three representative quotations have been given to illustrate any one point.

Results from using the Qualitative Method

1. The restriction of the biologist's concept of 'animal'.

In terms of the instances and non-instances of animals provided, only 4 pupils classified them as animals or not animals in the same way as the concensus view of biologists. Not only did the range of exemplars differ from that of biologists for most pupils, but also the criterial attributes.

Most pupils, particularly the younger ones, saw animals as mainly the land animals, such as those found on a farm, in a zoo, or in the home as pets. These would be the first animals they experienced and their concept of 'animals' has remained restricted.

The following attributes were used to categorise instances and non-instances of the concept of animals:

A. Number of legs. This was used by all but 6 of the 39 pupils interviewed, at least once in the interview.

i. Four legs

"Yes, it's got 4 legs..." (cat, 012, 013, 014, 016, 017, 018 100, 102, 105, 303, 307, 501, 506, 507)

"No, because animals don't have 8 legs." (spider, 018, 101, 106)

ii. Two legs

"No, because it's only got ... 2 legs." (bird, 102, 309)

iii. Six or eight legs

"No, it's an insect ... its got 8 legs." (spider, 011, 017, 100, 303, 304, 306, 309, 501, 502)

iv. No legs

"No, it's got no legs ..." (worm, 013, 014, 018, 102, 303, 305, 501, 505, 506)

v. Legs in general

"Yes, it's got legs." (frog, 305)

"No, ... animals have legs, cars have wheels." (car, 012, 016, 018, 102, 126)

B. Size was used as a criterial attribute by approximately one third of the pupils at least once in the interview.

i. Animals are a large size

"Yes, (it's) big ..." (cow, 012, 309, 507)

ii. Insects are the small creatures

"No, it's an insect, most insects are small." (worm, 017, 502)

That insects are small creatures, was also conveyed at the end of the interviews when the pupils were asked to give their meanings for such words as 'insect', 'animal', 'mammal'.

"An insect is something quite small ..." (017, 018, 301, 303, 305, 306, 307, 309, 504)

C. Habitat was used by just over half (56%) of the pupils at least once in the interview.

i. Animals are found on land

"Yes, it's on (the) land ..." (elephant, 303, 502, 104)

"Yes, it could go as an animal and its sort of like the rock cod. It's a fish, and then it turns into a frog, which is like an animal because it can live on land." (frog, 104, 502, 504)

"No ... (it) lives under the water." (fish, 013, 014, 103, 126)

ii. Mammals are the creatures in the sea

"No, it's a mammal because it lives in the sea." (whale, 110, 307, 502, 506)

"No, not really. A mammal ... mammals are mostly things that live in water." (fish, 017, 102, 307, 504)

This conception may have arisen from the teaching about the conservation of the endangered whale species, often done in Standard 3 or 4. The word 'mammal' may have been experienced by some children in connection with only the whales and dolphins - the marine mammals.

iii. Animals are found on a farm or are kept as pets

"Yes, it eats and usually (it is) found on farms and farms usually have animals on them." (cow, 308, 126, 502)

"Yes, it's a pet, you can keep it, so it must be an animal." (cat, 309, 504)

iv. Animals are found in the jungle or in the wild

"Yes, it lives in the jungle." (elephant, 103, 016, 102, 104)

D. Animals have fur

"Yes, it's got fur ..." (cat, 014, 017, 018, 102, 103, 105, 106, 502, 504)

"No, it's got ... no fur." (worm, 103)

E. Noise production

"Yes, ... makes sounds." (cat, 504)

"Yes, ... talks." (boy, 504, 509)

These characteristics, for example, four legs, terrestrial, fur, size, whilst characteristics of some animals, are not characteristic of all. When used as criterial attributes they limit the range of concept exemplars and result in restriction of the scientifically-accepted concept.

2. Confusion between the scientific criterial attributes of living things and scientific criterial attributes of animals

Approximately 54% of the pupils used the criterial attributes of living things (MRS GREN) as the criterial attributes of animals. Whilst they are characteristics of animals, a biologist would not consider them criterial attributes, as they do not distinguish animals from other living things, for example, the plants. The following were used as criterial attributes of animals:

A. Living creatures

"Yes, it's a living creature." (bird, 016, 105, 110, 301, 307,509)

"No, ... it's not living." (car, 501)

Only one scientifically incorrect classification was made:

"Yes, because it's actually living." (fire, 010)

B. Breathing and reproduction

"Yes, ... it breathes." (cow, 107)

"Yes, ... it breathes air, and it eats plankton ... they reproduce." (whale, 106)

"Yes, it reproduces." (worm, 107)

"Yes, it produces kittens." (cat, 108)

"Yes, it reproduces, it breathes, it eats, excretes, lives." (spider, fish, 509)

3. The use of scientifically-acceptable criterial attributes

A. Approximately one half of the pupils at least once in the interview, distinguished animals from plants on the basis of movement, and a well developed nervous system. While these are not characteristics of all animals, they do pertain to animals more than to plants, and, for given particular instances, may be acceptable to a biologist as criterial attributes.

i. Movement

"Yes, because it moves." (frog, 018, 105, 107, 109 110, 301, 302, 308, 309)

"No, it grows in the ground and doesn't move around like an animal does ..." (grass, 014, 011, 018, 105, 106, 110, 308, 309, 505)

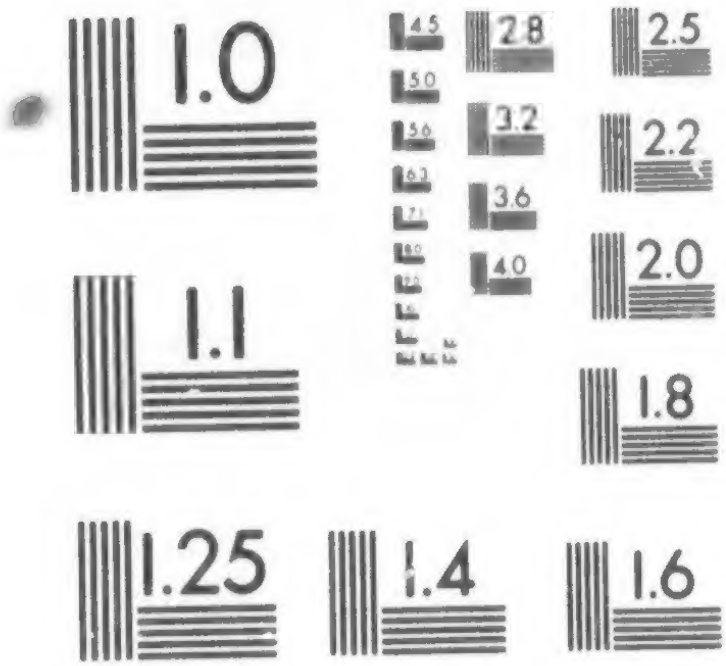
ii. A well developed nervous system

"Yes, ... its got a brain". (fish, 110)

"Yes, ... he's got the five senses". (boy, lion, 105)

B. Other pupils used the two main criterial attributes a biologist would use, that is, heterotrophic feeding (feeding on other living things) and cells.

i. A few pupils used the criterial attribute of feeding but in the same way as feeding is used as an attribute of living things. They did not emphasise the heterotrophic nature of animal feeding.



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

"Yes, ... it feeds." (spider, 301, 104, 108, 110, 306, 308, 509)

"No, ... it doesn't eat." (fire, 301, 304, 306)

Fourteen pupils had the added denotation of heterotrophic feeding, but usually only carnivorous (meat eating), not herbivorous (plant eating), as well. However, no pupil used this with all the instances or as the sole criterial attribute.

"Yes, it lives like other animals, and it goes around and eats other animals." (lion, 304, 307, 505, 508)

"Yes, ... it still feeds off other things." (snail, 508, 103, 107)

"No, it's sort of a species of plant because it doesn't really eat food like animals." (grass, 104, 108, 507)

The decomposers were not acknowledged as consumers by most pupils.

"No, its a plant, it eats from the ground, it doesn't eat other animals or vegetables." (mushroom, 301, 508, 509)

"No, they don't eat." (mushroom, 018)

One pupil did, however, consider other plants that are consumers:

"Some plants are animals ... because some plants eat things, like a (Venus) fly-catche " (308)

ii. Cells

The attribute of possessing cells was used by two pupils. The first:

"No it's a plant ... it's got chlorophyll and the cell has a different sort of structure ..." (grass, 501)

But the cell structure was mentioned only in connection with the grass.

The second pupil did not mention the different structures of animal and plant cells but used cells as an attribute of living things.

"Yes, ... it's got living cells." (cat, frog, elephant, snake, 308)

Summary of the Findings of the Qualitative Phase

Four pupils (301, 302, 508, 509) categorised all the animal exemplars as would a biologist. However, none of these pupils used only scientifically acceptable reasons to categorise the instances.

Only about a half of the remaining pupils categorised a fish, boy, frog, snail, snake, or whale as an animal. Few pupils categorised a spider, a worm or a butterfly as an animal. In contrast, the cow, cat and lion were classified by all pupils as animals, and the elephant by all, except one.

The pupils usually restricted the concept of 'animal'. Birds, fish, insects, and humans were not seen as a subset of animals but as comparable sets to the set of animals.

Many pupils did consider fish, birds, insects as animals, as subsets of the set animals, but, as mentioned above, only four pupils considered all of them as subsets.

The small creatures were often classed as insects because of their size. This was perhaps to be expected as no other alternative names, eg mollusc, were known to them.

A common and a scientific use of the word 'animal' was evident. In common use the word refers to only a small proportion of the instances in the biologists' concept. Only one pupil had an awareness of this double meaning, but despite this he was unable to categorise the instances as would a biologist.

I. "In the first one (card) you said "Oh, it probably is some kind of animal, but I wouldn't use the word with a seagull." Could you explain that a bit more?

S. Oh, what comes to mind as an animal - it's usually a four-legged thing that walks around ... I know really it (the seagull) is an animal.

I. When would you say it is an animal. Is there a particular situation whereby you'd say 'Yes, that is an animal'?

S. Yes, kind of in a biology lesson and that, science, we'd say it would be an animal." (303)

Of the 39 pupils interviewed, 35 could not classify all the animal instances correctly, nor know or use the scientifically acceptable criterial attributes of animals. Characteristically, their concepts were a restriction of the scientific one, the range of exemplars being narrower than that of a scientist.

The Quantitative Phase

One of the disadvantages of the interview-about-instances technique is the prohibitive effort in investigating a large sample of pupils. In the total sample of 39 pupils who were interviewed as to their meanings of the word 'animal', only 12 Form 1 pupils, for example, were interviewed. Whilst the in-depth, qualitative data obtained from the interviews was illuminative as to the concepts held by some pupils, it was not possible to assess accurately the responses most common to each age group. Yet this is one kind of information required before decisions on curriculum changes can be made. To acquire incidence data from a larger number of pupils at any one age level as to their concept of 'animal', an objective test was therefore, designed and used.

A six question multiple choice test (see Appendix A) was developed, based on the interview-about-instances results.

Each of the six questions was in two parts, (a) and (b). Part (a) required the pupils to categorise an instance as an animal or not. The six instances to be categorised were a spider, a grass plant, a cow, a worm, a person, and a whale; that is, 5 exemplars of an animal and one non-exemplar. However, of the 5 exemplars of an animal, only one (the cow) was considered an animal by many of the children, who had been interviewed. The spider and worm were included as many interviewed pupils, incorrectly, categorised them as non-animals, and also insects, in the initial interviews-about-instances. The person and the whale were included as many interviewed pupils had had difficulty categorising them as would a scientist.

Part (b) required the pupils to give reasons for their answers to (a). The pupils were asked to select four reasons from a list of 26 provided. Two "List of Reasons" were used. One list, for use with tertiary (and senior secondary) pupils (see Appendix B) included the criterial attribute of cell structure (reasons K, L) which most pupils would have encountered in formal biology lessons by the age of 15 or 16. This attribute was not present in the "List of Reasons" used by the intermediate and junior secondary pupils as they may not have had formal tuition on cells, or cell structure. Instead characteristics Y: 'It lives in the sea' and Z: 'It lives on land' were expanded to include both the positive and negative forms to become: K: 'It lives on the land', L: 'It does not live on the land' and Y: 'It lives in the sea', Z: 'It does not live in the sea'. In all other respects the two lists were identical.

The list included the criterial attribute:

G: 'It eats other living things' and H: 'It does not eat other living things'

and for the older students:

K: 'It has cells with a cell wall' and L: 'It has cells with no cell wall'.

Two characteristics, movement (A,B) and possession of a brain (S,T) are characteristics of most animals, especially the commonly known ones. The animal exemplars used in the test, were chosen on the basis that they would be recognised and known by the pupils, including the Form 1 pupils. All the animal exemplars in the test do move and do possess a brain. Whilst these two characteristics are not common to all animals, a biologist may, in a casual way, and in conjunction with other characteristics, use them to distinguish between animals and plants.

The characteristics of the number of legs (U, V, W, X) and noise production (E,F) are characteristics of only some animals and would not be used by biologists as criterial attributes.

Four classificatory reasons (M, N, O, P) were included for two purposes:

a. to identify those pupils who perceived animals as a comparable set to insects or mammals for example, rather than as a superordinate category.

b. to provide scientifically correct choices for those pupils who had already chosen the criterial attributes and did not want to choose scientifically unacceptable characteristics to give a total of four reasons as requested.

Attributes used by young children in the interviews were also included, namely size (C, D), possession of fur (I, J), and habitat (Y, Z, and K, L in the younger pupils' version).

A criterial attribute of living things, rather than of just animals, was also included - breathing (Q, R).

The multiple choice test was administered to 49 Form 1 pupils, 34 Year 1 Teachers College students, and 67 University students taking a Part 1 biology course, in normal timetabled science lessons. All subjects were instructed to answer the test as would a scientist or biologist.

Results of the Quantitative Phase

All three samples of subjects categorised the grass as a non-animal, and the proportions of subjects from each of the three samples, categorising the other instances as an animal or not are illustrated in Figure 3.

While 97% of the University students categorised the spider as an animal, only 65% of the Teachers College students, and 22% of the Form 1 pupils did likewise.

A similar trend was evident in the results of the worm question. 99% of the University students, 77% of the Teachers College students and 37% of the Form 1 pupils categorised the worm as an animal.

The results of the person and whale questions showed this trend to a lesser degree. All of the University students, 94% of Teachers College students, and 57% of the Form 1 pupils categorised the person as an animal. 100% of the University students, 79% of the Teachers College students, and 47% of the Form 1 pupils classified the whale as an animal.

All three groups of students made more correct biological categorisations when the instance to be classified was more like the 'typical' animal, for example, the cow, and other mammals. For all instances, the results of the Teachers College students were intermediary between the Form 1 pupils and the university students, who as a group, had a concept that approximate closely to the biologist's concept of an animal, with respect to the exemplars.

The proportion of the total number of times, each reason was used by each sample was analysed. Overall, the five most frequently chosen reasons by the University students were:

S: 'It has a brain' (15% of all responses)
Q: 'It breathes' (14%)
L: 'It has a cell with no cell wall' (12%)
A: 'It moves' (10%)
G: 'It eats other living things' (9%)

These five reasons accounted for 60% of all the reasons chosen. All but one (Q: 'It breathes') can be used conjunctively to distinguish animals from non-animals in a scientifically acceptable way.

The five most frequently chosen reasons by the Teachers College sample were:

S: 'It has a brain' (14% of all responses)
Q: 'It breathes' (13%)
A: 'It moves' (9%)
N: 'It is a mammal' (8%)
U,V,W,X: Number of legs (8%)

These five reasons accounted for 52% of all reasons chosen. Only two (S, A) would be used by a biologist to distinguish animals from non-animals.

The five reasons most frequently chosen by the Form 1 pupils were:

U,V,W,X:Number of legs (16% of all responses)

A: 'It moves' (11%)

Q: 'It breathes' (9%)

S: 'It has a brain' (8%)

K: 'It lives on land' (8%)

These accounted for 52% of all reasons chosen.

For all groups of students, the characteristics of a brain, breathing and movement were in the group of the five main reasons chosen. Breathing, in the sense of gaseous exchange, is not a criterial attribute of animals. The other two characteristics do pertain more to the animals than to the plants and when used in conjunction with other characteristics, may be considered, in a casual sense, criterial attributes by a biologist.

Overall, the characteristics of number of legs (U, V, W, X); habitat (it lives on land or in the sea); possession of fur (I,J); noise production (E,F); size (C,D); and movement (A) were chosen more often by the Form 1 pupils than by the tertiary students. All these characteristics, except that of movement, are non-criterial attributes of animals, and would not be used by a biologist to distinguish between animals and other living things.

51% of the University students, 77% of the Teachers College students and 71% of the Form 1 pupils called a spider an insect, which is scientifically incorrect.

The criterial attribute 'It eats other living things' was chosen, overall, and in decreasing order, by the University, Teachers College and Form 1 students.

The other criterial attribute of cell structure (reason G or H), which was only in the list of reasons used by the tertiary students, was selected more frequently by the University students than by the Teachers College students, in all six questions. That Teachers College students tended not to use the characteristics of heterotrophic feeding and cellular structure to the same extent as the University students, may account for the higher usage by Teachers College students of the other reasons, for example, habitat, and number of legs. The lack of knowledge of biological criteria may have led to the use of these criteria by the younger pupils, but over 85% of the Teachers College students had done a secondary school course in senior biology. It would appear that they did not see to use this information and that the other reasons acted as distractors.

In conclusion, 14% of the Form 1 pupils, 59% of the Teachers College students and 97% of the university students correctly categorised all 6 instances in the test from a scientific viewpoint (see Figure 3). No student from any sample chose only criterial attributes for the selected reasons. The Form 1 pupils tended to choose non-criterial attributes to a greater extent than the tertiary students, and the Teachers College students more than the university students.

Even at the university level, it cannot be assumed that biology students have a concept of 'animal', with respect to either the exemplars or the reasons used in the categorisation, that would be scientifically acceptable.

With respect both to the categorisations and some of the reasons chosen, the Teachers College students, as a group, were intermediary between the University students and the Form 1 pupils. This means that while some Teachers College students have a concept of 'animal' that is similar to that of a biologist, some have a concept similar to the Form 1 pupils. In two years time, these Teachers College students may be teaching science (including biology) to other Form 1 pupils. Rather than shifting the concepts of their pupils towards a scientifically acceptable one, they may reinforce the restricted concept of 'animal'.

It cannot be assumed that students at the tertiary level (and therefore at primary and secondary levels as well) know of and can use the biological criteria for distinguishing between animals and non-animals. When students, of all ages, use, hear or read the word 'animal' they may not attach to it the precise biological meaning as would a biologist. Students, even after five years of secondary school tuition in biology , may have a concept of 'animal' that lies somewhere on the continuum between the young child's concept of 'animal' as the 'typical' animal, a four-legged terrestial mammal, and the biologist's concept of 'animal'.

Implications for the Teaching of Biology

Many intermediate and secondary pupils did not appear to have a scientific concept of 'animal'. It may be argued that pupils may have had a biologist's concept of 'animal' as well as the everyday concept. However, even if they had a concept of animal in a biological sense, they tended not to use it nor even to appreciate the ambiguity in the questions. In the extreme case of tertiary biology students, the context of the biological laboratory and instructions to answer the test as would a biologist, did not provide sufficient clues that they should use the biologist's concept if they had it. One can only assume that if the students had a biological concept of an animal, they still tended to interpret dialogue and act in terms of the everyday use of the word.They appeared insensitive to the potential ambiguity in the use of the word 'animal'. Pupils need to be aware of the appropriate use of both the common and the scientific meaning of the word 'animal'. The sign in many food shops 'No animals allowed' cannot be interpreted from a biological perspective, if one is wanting to enter the shop to purchase food.

As children do have a concept of an animal, although it tends not to be the scientifically acceptable one, the task of the science teacher, wishing to teach the biological concept of 'animal', is not so much to develop the concept but to clarify and distinguish the similarities and differences between the everyday and the scientific concept of 'animal'.

A pilot study has been conducted (Stead, 1980a) aimed at modifying the concepts of a small sample of 8 average ability Form 1 pupils. The main emphasis was that suggested by Nussbaum and Novick (1980) - to challenge the concepts the children do have, and to highlight their inadequacies. The scientific concept was then offered as a solution to the dissonance experienced. Learning of the scientific concept focussed on the learning of the rule to distinguish animals from other living things (animals eat other living things) and the practising of categorising the instances and non-instances in a scientific way. The pilot study results indicate that it is possible to modify the concepts of 'animal' held by some Form 1 pupils, towards the scientific one.

This paper has attempted to emphasize, through a detailed analysis of one particular concept, the importance of establishing the learner's concept of even the most basic ideas upon which a curriculum is based. With respect to the concept 'animal', it is our view, from our knowledge of the syllabi and typical science teaching at the Form 1-4 level, that most of us as teachers and curriculum developers, simply assume that children at this level have the biological concept of 'animal'. In our view, such an assumption needs to be reconsidered.

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	Standard 4	Form 1	Form 3	Form 5	Total
Number in Sample	9	12	9	9	39
Pupil Code numbers	(010-018)	(100-110) and 126	(301-309)	(501-509)	

Pupils of above average ability : 301, 302, 303, 304, 508, 509
Second Year Form 5 Pupil: 501

Figure 1 The Interview Sample

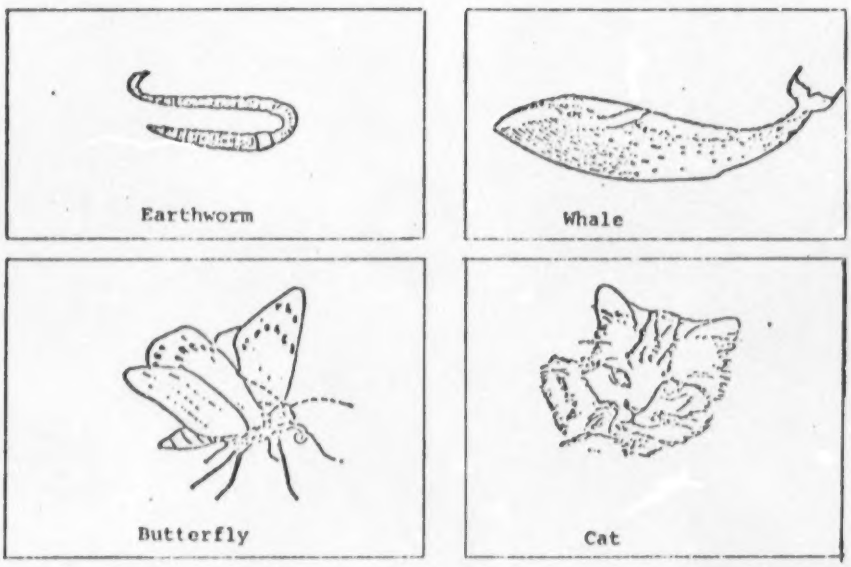


Figure 2 A Sample of Cards Used in the Animal Interview-about-Instances

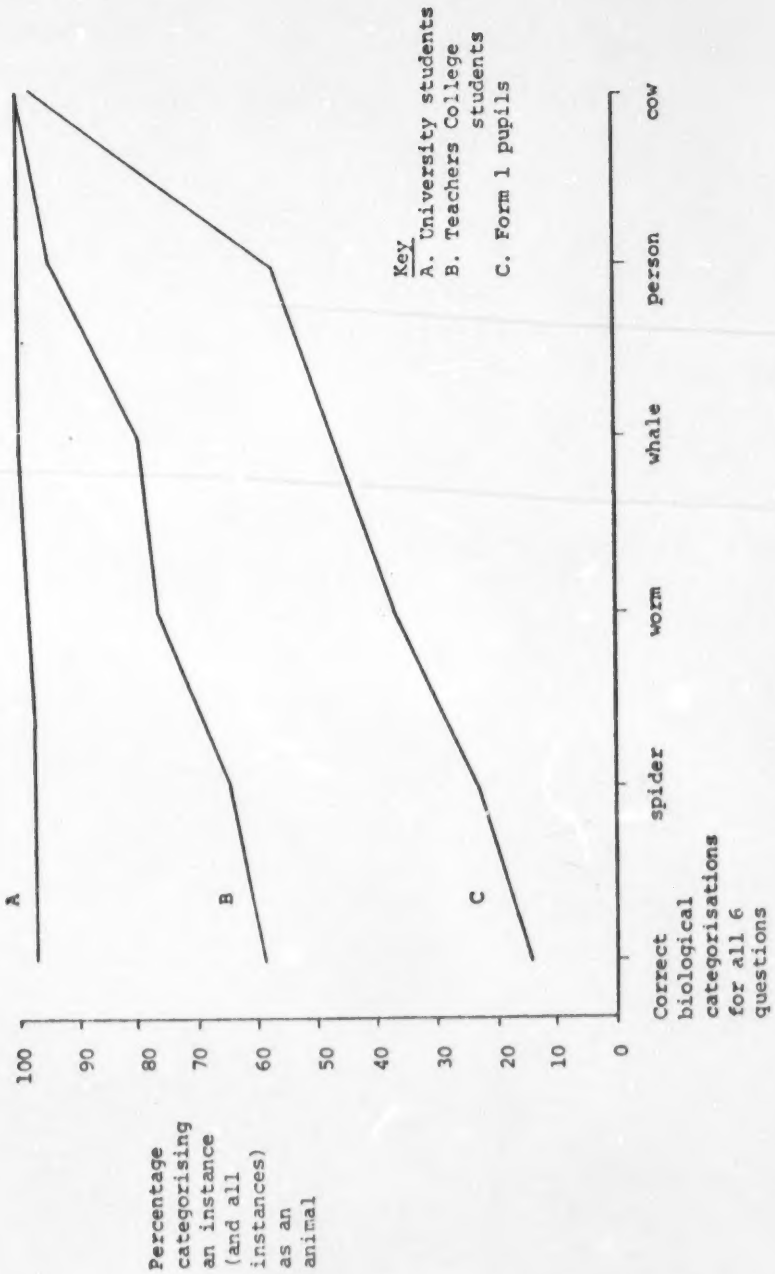


Figure 3. The proportions of students from each of the three samples who categorised an instance as an animal

3. (a) Is a cow an animal? Yes ☐ No ☐

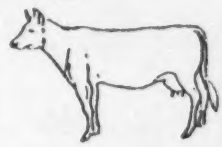
(Put a tick in one box)

(b) Look at the "List of Reasons" on the separate sheet and choose FOUR of them.

These should be the ones you think are the BEST

Put a tick in the box beside the letters.

A ☐	H ☐	O ☐	V ☐
B ☐	I ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	



4. (a) Is a worm an animal? Yes ☐ No ☐

(Put a tick in one box)

(b) Look at the "List of Reasons" on the separate sheet and choose FOUR of them.

These should be the ones you think are the BEST.

Put a tick in the box beside the letters.

A ☐	H ☐	O ☐	V ☐
B ☐	I ☐	P ☐	W ☐
C ☐	J ☐	Q ☐	X ☐
D ☐	K ☐	R ☐	Y ☐
E ☐	L ☐	S ☐	Z ☐
F ☐	M ☐	T ☐	
G ☐	N ☐	U ☐	

Appendix A. A sample page from the multiple choice test on 'animal'.

List of Reasons

A. It moves.

B. It does not move.

C. It is large.

D. It is small.

E. It makes a noise.

F. It does not make a noise.

G. It eats other living things.

H. It does not eat other living things.

I. It has fur.

J. It does not have fur.

K. It has cells with a cell wall.

L. It has cells with no cell wall.

M. It is an insect.

N. It is a mammal.

O. It is a fish.

P. It is a human.

Q. It breathes.

R. It does not breathe.

S. It has a brain.

T. It does not have a brain.

U. It has many legs.

V. It has no legs.

W. It has two legs.

X. It has four legs.

Y. It lives in the sea.

Z. It lives on the land.

Appendix B. The 'List of reasons' used in the 'animal' multiple choice test by the tertiary students.